XXXIX. *Continuation of an experimental Inquiry concerning the Nature of the mineral elaſtic Spirit, or Air, contained in the* Pouhon *Water, and other Acidulæ. By* W. Brownrigg, *M. D. F. R. S. Addreſſed to Sir* John Pringle, *Bart. F. R. S.*

TO SIR JOHN PRINGLE, BART. P. R. S.

SIR,

Redde, April 28, 1774.

YOU have often, with others of my friends, been pleaſed to inquire after the continuation of my experiments on the mineral water of SPA, which I promiſed to communicate to the Royal Society, with a view to explain "the mode of union that exiſts between the "air of thoſe waters, and the other principles of "which they are compoſed, together with the "relation which that elaſtic fluid bears to common "air, and to various other bodies (*a*)." Thoſe expe-

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(*a*) See Concluſion to an experimental Inquiry concerning the mineral elaſtic Spirit, or Air, contained in Spa Water, &c. Philoſophical Tranſactions, Vol. LV.

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riments I, indeed, intended to have preſented to the Royal Society, ſoon after my experiments on the ſame ſubject had been honoured with its approbation; but was, at that time, prevented from putting them in due form, by other more preſſing engagements; and, afterwards, thought the publication of them the leſs neceſſary, as a ſimilar mode of union between various abſorbent earths and water, by the medium of mephitic air, had been ſo fully explained by the Hon. HENRY CAVENDISH, in his excellent treatiſe on the RATHBONE-PLACE waters (*b*); and the ſolubility of iron in water, by means of the ſame air, had alſo been demonſtrated by Mr. LANE, in his valuable experiments on that ſubject (*c*). However, as my obſervations and experiments are different from thoſe of the above-named gentlemen, and the great efficacy of this aëreal ſolvent is by them ſhewn, in a variety of inſtances; and, more eſpecially, as a coagulating power in other kinds of air is alſo there detected; by which, and the diſſolving power of mephitic air, many great changes in bodies are daily produced, I therefore now lay theſe papers before you, requeſting, that if, after ſo long an interval, I may again be allowed to reſume this ſubject, you will do me the honour to communicate them to that moſt reſpectable body, over which you ſo worthily preſide. I am,

SIR,
Your moſt obliged,
and moſt obedient ſervant,
WM. BROWNRIGG.

(*b*) Philoſophical Tranſactions, Vol. LVII. p. 92.
(*c*) Phil. Tranſ. Vol. LIX.

PROPOSITION THE FIRST.

The ferruginous and abſorbent earths contained in the Pouhon *water are kept diſſolved therein, by means of the mephitic air, to which thoſe earths are united.*

IN an *Inquiry concerning the nature of the mineral and elaſtic ſpirit, or air, contained in this water*, publiſhed in the Tranſactions of the Royal Society (*a*), it hath been ſhewn (*b*), that when the POUHON water is excluded from all contact with the common air, in ſuch manner that the mephitic air which it contains has free liberty to fly from it into an empty bladder, this air does not ſeparate from the water by any ſpontaneous motion, as it would from its rare texture and elaſtic force, was it at liberty to exert theſe its qualities: but, on the contrary, in this ſituation, it remains united to the other ingredients of of the water, when expoſed to the moſt intenſe heat that we uſually obſerve, in the open air, in this our climate.

It hath been further ſhewn (*c*), that this elaſtic fluid, when excluded from common air in the manner before related, is but ſlowly expelled from the POUHON water by a heat of 110 degrees of *Fahrenheit's* thermometer, although ſuch heat is ſufficient to raiſe water (a much heavier body) in diſtillation:

(*a*) Vol. LV. p. 233.

(*b*) Experiment the firſt of the ſaid Inquiry.

(*c*) Experiment the ſecond.

and ſo cloſely is air united to the other ingredients of the water, that it is not wholly expelled from them by a ſcalding heat of 160 or 170 degrees of the ſcale, when expoſed thereto for two hours.

Which experiments therefore prove, that this air is not detained in the POUHON water, by the preſſure of the atmoſphere, or by any other external force, as is the air with which beer, or other fermenting liquors, are often ſurcharged, while they are confined in bottles: but that this elaſtic fluid is equally mixed with the watery element, and with the other ingredients of which this mineral water is compoſed, and exiſts with them in a ſtate of ſolution, or in a fixed ſtate, being attached to the water, and to the other ingredients diſſolved therein, by a force ſufficient to keep them all united together in one uniform compound, while this force is not removed by ſome external cauſe.

It further appears, from the ſame experiments (*d*), that ſo long as this air continues united to the other ingredients of the POUHON water, its martial and abſorbent earths do alſo remain ſuſpended therein; but, ſo ſoon as any part of this air is expelled by heat, thoſe earths begin to ſeparate from the water, which then grows white and turbid; and when, by continuance of the heat, more of this air is expelled, more of the earthly particles alſo ſeparate from the water, in the ſame proportion as its air is ſeparated from it; and while only a ſmall portion of the air remains, ſome portion of the martial earth alſo remains diſſolved in the water, as appears from its

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(*d*) See Experiment the ſecond.

giving a ſlight tinge of the purple, when mixed with galls: but none of thoſe earths are any longer detained in the water, than while it continues impregnated with ſome mephitic air; when this air is entirely ſeparated from the water, it is wholly decompounded, having loſt its diſtinguiſhing briſk and pungent taſte, and its power of ſtriking a purple colour with galls; its more volatile and elaſtic principles being exhaled, its metalline and abſorbent earths then ſubſide in a white flocculent ſediment, and no other ſubſtance remains diſſolved in the water, ſave only the ſmall portion of alkaline and neutral ſalts, which enter its compoſition.

From this ſhort recapitulation of the above-mentioned experiments, it therefore appears, that the POUHON water undergoes a decompoſition, when its air is expelled from it by means of heat. The oppoſite extreme of cold is alſo found to produce the ſame effect of decompounding the POUHON water, when this its aëreal principle is expelled from it by means of congelation.

For having poured ſome of this water into open tin veſſels, that were placed in the common freezing mixture of ſea-ſalt and ſnow, ſo ſoon as the water began to ſhoot into ice at the bottom and ſides of the veſſels, very minute bubbles of air inceſſantly aroſe therein, and were diſcharged from its ſurface with ſuch force, as to carry with them ſmall particles of the water to a conſiderable height; and continued thus to fly off, till all the water was congealed. The ice was very white, from the minute bubbles of air, which were every where interſperſed though it, and by which the frozen water con-

conſiderably increaſed in bulk, ſo as to riſe at its ſurface into a very convex form. The water, when thawed, was white and turbid, and ſoon let fall its metallic and abſorbent earths in a white ſediment: it then had almoſt loſt its taſte; and, being mixed with tincture of galls, only gave therewith a ſlight purple tinge. By a ſecond congelation, it ſeemed almoſt entirely deprived of its air, and, with it, of the remaining part of its white earths; and, when decanted from its ſediment, no longer ſtruck a colour with galls. From theſe experiments it therefore appears, that ſo ſoon as this water is deprived of its air, whether it be by heat or by cold, it is no longer capable of keeping thoſe earths diſſolved, which, while it is impregnated with this air, continue ſuſpended therein.

In theſe decompoſitions of the POUHON water, by heat and by cold, no volatile ſpirit, either acid or ſulphureous, nor any other ſubtile matter, has been found to fly from it, ſave only its mephitic air: while this air is preſent in the water, its martial and abſorbent earths remain diſſolved therein; ſo ſoon as this air is ſeparated from the water, in whole or in part, thoſe earths, either in the whole or in part, do alſo ſeparate from it, and are no longer ſuſpended therein, than while they are united to a due proportion of this aërial ſolvent. From whence it appears, that this mephitic air is the medium by which the metalline and abſorbent earths contained in the POUHON water are therein held in ſolution; and, contrary-wiſe, that thoſe earths are the medium, by which this air is more firmly united to the watery element in this compound, in which it enters as a

principal

principal ingredient, and, by its ſolution in the water, and its union with theſe earthy ſubſtances, from a a very rare volatile and elaſtic body, is reduced to a fixed ſtate.

This diſſolving power of mephitic air may farther be proved from the recompoſition of the POUHON water, by adding thereto the air expelled from it by coction. But as Mr. CAVENDISH has already ſhewn, that the abſorbent earths of RATHBONE-PLACE water may be rediſſolved by the mephitic, or fixed air, which had been extracted from that water; and as Mr. LANE has alſo demonſtrated, that iron is rendered ſoluble in water, by the medium of mephitic air, I therefore ſhall not, at this time, detain the Society with my experiments on the ſame ſubject; but as thoſe experiments contain ſome phænomena, that have not yet been noticed, I may, perhaps, offer them to the public on ſome future occaſion.

SCHOLIA.

From the foregoing experiments, it appears that the mephitic air and martial earth, contained in the POUHON waters, ſtrongly attract each other, and, uniting together, form a concrete ſoluble in water, and readily diſtinguiſhed therein, by the peculiarly briſk acidulous taſte, which it receives from this aëreal principle, joined to a rough ſubaſtringent taſte, which proceeds from the iron. This concrete, like other vitriols of iron, ſtrikes a black colour with galls, and may well be eſteemed a ſaline body of the neutral kind, of which the mephitic air conſtitutes

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the ſpirituous ſolvent, and the martial earth its baſe. It further appears, that the mephitic air is poſſeſſed of all the properties, by which ſome of the chemiſts have diſtinguiſhed thoſe pure and ſimple bodies, or ſpirits, which by them are eſteemed, in *their own nature*, and *of themſelves*, ſaline, and which, in union with other bodies, form ſalts that are more compound. For this aëreal ſolvent, in like manner with the pure acid ſpirits, is ſoluble in water, and imparts thereto its peculiar ſharp and acidulous ſavour: moreover, in combination with various metalline and abſorbent earths, this volatile elaſtic ſpirit, like thoſe acids, forms various ſaline concretes of the neutral kind; inaſmuch as thoſe metalline and abſorbent earths, when united to this elaſtic ſpirit, are thereby rendered ſoluble in water; and, in union therewith, acquire peculiar ſavours, reſulting, in part, from this their ſpirituous principle, and, in part alſo, from the particular kind of earth with which it is combined. This air, therefore, conſidered in the relation which it bears to ſeveral earthy ſubſtances, and to water; conſidered alſo as it impreſſes the organs of taſte, with its peculiar briſk and acidulous ſavour, may juſtly be ſtiled a *mineral elaſtic ſpirit of a ſaline nature*, and is ſufficiently diſtinguiſhed from all other ſaline ſpirits, by its great rarity, and by its aëreal nature. How far, and under what laws, this relation between mephitic air and various ſaline earths, and other bodies, may be extended, hath not yet been fully diſcovered: ſuffice it in this place to remark, that a claſs of ſaline bodies of a neutral nature are here detected, compoſed of various earthy baſes, united to a volatile aëreal ſpirit, all of which

which agree in one common ſolvent, the mephitic air, but differ from each other, according to the nature of the baſe to which this air is united.

The agreement of theſe ſaline concretes with neutral ſalts in theſe eſſential properties, by which theſe laſt are diſtinguiſhed from other more ſimple ſaline bodies, will further appear from their decompoſition; which is effected by thoſe various ways, and under the ſame laws, by which all other neutral ſalts are decompounded; namely, by all thoſe different ways, by which the acid ſpirits, and the terrene or alcaline baſes of neutral ſalts, can be ſeparated from each other.

For, *firſt*, the aëreal ſpirit of theſe ſaline concretes is forced, *by fire*, from its union with the earthy baſe, which it holds diſſolved in water, in like manner as the acid ſpirit of other neutral ſalts are expelled by fire from the more fixed principles, which enter the compoſition of thoſe ſalts. The degree of heat required to ſeparate the acid ſpirit of neutral ſalts, from their more fixed alcaline or earthy baſe, varies in the decompoſition of almoſt every different kind of ſalts; and the extreme volatility and expanſive force of this aëreo-ſaline principle renders it more eaſily ſeparable, by heat, from the fixed principles to which it unites, than any other kind of ſaline ſpirit.

Secondly. The ſaline concretes, formed with this aëreal ſolvent (in like manner as other neutral ſalts), are decompounded by the *addition of ſtronger acids*, which more powerfully attract the terrene or metallic baſe of theſe concretes, than it is attracted by their light and ſubtle aëreal ſpirit, and detaches from them the aëreal ſolvent to which thoſe earths were before united. All acids, found in a liquid form, have this effect, from the light vinous acids to the moſt ponderous acid of vitriol; ſo that the affinity between theſe metalline and abſorbent earths, and this their aëreal ſolvent, is leſs than that which exiſts between the ſame earths and all the known acid ſpirits. In all additions of theſe acids to the ſpirituous or acidulous waters, an efferveſcence has been obſerved, not readily accounted for, by thoſe who ſuppoſe an acid to predominate in thoſe waters. The conflict and diſcharge of air here ariſes from the expulſion of the aëreal principle from its terrene baſe; in like manner as the acids of ſea ſalt and nitre are expelled, with efferveſcence, from their alcaline baſes, by the more powerful acid of vitriol. And here, by the way, it may be proper to remark, that the vitriolic acid, when mixed with the *acidulæ* and other chalybeate waters, doth not preſerve thoſe waters from decay, as the excellent HALES, and others, after him, have ſuppoſed; but, on the contrary, deſtroys their texture, or decompounds them, by expelling their elaſtic ſpirit, and entering into new combinations with their earthy principles; thereby forming a new compound, leſs periſhable indeed than the former, but alſo leſs efficacious in the cure of many diſeaſes. When Rheniſh wine is added to the *acidulæ*, the large quantity of air that flies off may, in part, proceed from the wine; but when I mixed the vitriolic acid with POUHON water, a conſiderable quantity of air was indeed diſcharged; but not the whole which that water holds in ſolution. I therefore conjectured, that ſome part of the air, contained in that water, might be imbibed by the ſuperabundant acid, which

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I uſed in the experiment, and that more mephitic air might, perhaps, have been expelled from the water, had I only mixed with it the exact quantity of this acid, that was required to diſſolve the earthy ſubſtances contained therein.

Thirdly. Theſe ſaline concretes, contained in the POUHON water and other *acidulæ*, are ſubject to decompoſition, not only from acids, as before related, but alſo from *alcalies*, whether fixed or volatile: all which more powerfully attract this ſubtile aëreal principle than it is attracted by the martial and abſorbent earths, to which it is united in thoſe waters. And here again appears an exact agreement between theſe aëreo-ſaline concretes and various neutral ſalts, in the mode of their decompoſition. For the ammoniacal ſalts (which are all compoſed of the volatile *alcali*, united to an acid ſpirit, either muriatic, nitrous, or of ſome other kind) ſo ſoon as one of the fixed alcalies, or quicklime, is added to any of them, the acid ſpirit which it contains, quitting its union with the weaker volatile *alcali*, this laſt is let looſe; aud the ſtronger *alcali*, or quick-lime, takes its place; between which and the acid ſpirit a new combination is formed. The ſame happens when any *alcali*, either fixed or volatile, is added to the *acidulæ*; their elaſtic ſpirit then quits the ferruginous and abſorbent earths, to which it was joined, and forms a new combination with the *alcali*, by which it is more powerfully attracted than by theſe earthy ſubſtances. Theſe earths, therefore, being no longer ſuſpended in the water by the aëreal ſolvent, render it turbid and milky, until they have gradually ſubſided therein, in the form of a white ſediment:

ſediment: for ſuch is the native appearance of the martial earth, as well as of all the other earths contained in theſe waters, as will be ſhewn hereafter. In theſe decompoſitions of acidulous waters, by means of alcalies, no effervelſcence, or diſcharge of air-bubbles, takes place; for here the air is all abſorbed by the *alcali* added thereto, and not expelled from the water, as it is in the decompoſition of the ſame waters, by means of ſtronger acids.

When the *acidulæ* are mixed with common ſoap, a two-fold decompoſition takes place. The fixed *alcali*, quitting the unctuous ſubſtances, to which it was joined in the ſoap, unites itſelf to the aëreal ſpirit, or mephitic air, of thoſe waters, while this air, at the ſame time, deſerts the earthy ſubſtances with which it was before combined. The ſame new combinations ſeem to take place, when ſoap is mixed with any of thoſe waters which are uſually called hard; many of which waters have been found to contain an earthy ſubſtance, diſſolved by means of this ſubtile aëreal principle.

The above obſervations and experiments ſhew an exact agreement, in the ſeveral ways, by which the various neutral ſalts, and thoſe ſaline concretes formed of mephitic air united to an earthy baſe, are decompounded. It ought, however, here to be remarked, that the ſaline concretes, which exiſt in the POUHON water, in a diſſolved ſtate, though evidently of the neutral kind, have not hitherto been obtained in a ſolid form; owing, perhaps, in ſome meaſure, to the great volatility of their ſpirituous principle; but chiefly to their being ſubject to decompoſition, from the precipitation of their earthy baſe, by means of common air, during the evaporation of the water in which they are diſſolved, as will be ſhewn hereafter.

The mephitic air of the *acidulæ*, although it is ſoluble in water, and imparts thereto its briſk and pungent taſte, which has been uſually ſtiled ſubacid; and although it produces effects exactly ſimilar to thoſe of acid ſpirits (by readily uniting to various earthy ſubſtances, which of themſelves are not ſoluble in water, but, by their union with this aëreal fluid, are rendered ſoluble therein, and communicate to the water peculiar ſavours, and form therein ſaline concretes of the neutral kind; which concretes, ſo formed, are again ſeparable into their component ingredients, by all thoſe ways by which the acid and alcaline principles of other neutral ſalts are ſeparable from each other) yet it differs from all acid ſpirits, found in a liquid form, in its rare texture and its elaſtic quality, and in not ſtriking a red colour with ſyrup of violets, and other blue tinctures of vegetables; which change in the blue colour of thoſe tinctures, is uſually eſteemed a teſt of the preſence of an acid. Beſides the trials which other gentlemen and myſelf have made, by mixing ſyrup of violets with pure water, impregnated with various kinds of mephitic air, in which no change in the colour of the ſyrup was obſerved, I have for ſeveral days ſuſpended pieces of linen, that had been dyed blue with freſh juice of violets, in the mephitic air of SPA water, and alſo in that of chalk; and, when the linen was taken out of the ſaid air, did not perceive its blue colour in any wiſe changed, although the ſame pieces of dyed linen were inſtantly turned of a green colour, when expoſed to the fumes of ſpirit of hartſhorn. Whether therefore, and under what relations, this aëreo-ſaline ſpirit may merit the title of an *acid*, I leave to the determination of others. Such, however, it has appeared to be to many philoſophers, ſince this mephitic air is doubtleſs the ſame with the *acidum vagum fodinarum* of BOERHAAVE and others; and with the *acidum centrale perpetuum inexhauribile* of BECHER; with the *ſpiritus ſulphureus aëreo-æthereo-elaſticus* of HOFFMAN; and the *ſal embrionatus* and *ſal eſurinus* of the ſagacious HELMONT, which, he ſays, corrodes the ore of iron, and with it forms a volatile vitriol in the POUHON water. All theſe, and many other philoſophers, had acquired ſome knowledge of this ſubtile aëreo-ſaline principle from contemplating its effects; but, not having obtained it in a palpable form, were unacquainted with ſeveral of its principal properties.

From conſidering the great ſubtility of this aëreo-ſaline principle, its power of diſſolving many earthy ſubſtances, together with its property of uniting readily to water, and with it, of pervading the very minute veſſels of the animal frame, without injuring them, as ſtronger acids do by their corroſive quality, we may from thence form ſome judgement of the great efficacy of this air, as a *de-obſtruent* and *ſolvent*, in many diſeaſes of the human body ariſing from preternatural concretions and obſtructions thence enſuing. If to theſe we add the great antiſeptic powers of this kind of air, which it poſſeſſes in common with acids (and which were firſt detected by SIR JOHN PRINGLE, and have ſince been more fully explained by Mr. MACBRIDE and Dr. PRIESTLY); we then, in ſome meaſure, may account for thoſe extraordinary effects, which this kind of air is found to produce in the cure of many obſtinate diſeaſes, with which mankind are afflicted.